Demystifying Active Format Description

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What is AFD?

Active Format Description (AFD) is a new SMPTE standard for both standard-definition and high-definition systems. It is a method of identifying the aspect ratio of a picture by inserting flags (metadata) into the vertical ancillary data space (VANC). These flags describe the aspect ratio for the purpose of signaling downstream aspect ratio details. In the future, this capability will extend into the display device as well.

AFD is one of three types of metadata. The other two are bar data, which describes the unused portions on the image, and pan-scan information, which is used in the post-
production process. This paper focuses on AFD.

Distinguishing factors:

AFD and Bar Data

- broadcast with the video signal that they describe

- used in DTV receivers and/or intermediate professional video equipment

- guide the display of video of one aspect ratio on a display of another aspect ratio

Pan-Scan

- not intended for use beyond the production and distribution environments

The following suite of SMPTE standards defines the origination and carriage of AFD, bar data and pan-scan information:

1) SMPTE 2016-1 format for AFD and bar data

2) SMPTE 2016-2 format for pan-scan information

3) SMPTE 2016-3 vertical ancillary data mapping of AFD and bar data

4) SMPTE 2016-4 vertical ancillary data mapping of pan-scan information

5) SMPTE 2016-5 KLV data coding for AFD, bar data and pan-scan information

Today's set-top boxes (STBs) and television sets are "dumb" when it comes to optimizing aspect ratio. DVDs contain something similar to AFD data, but the DVD players need to be told if the TV is 4:3 or 16:9 for the content to display properly.

If the AFD information is available when upconverting (SD to HD) or down-converting (HD to SD), and the up- or downconverter is "AFD aware," then the aspect ratio is automatically optimized as it passes through.

In a similar fashion, if the AFD information is available when displaying an SD or HD signal, and the display device (4:3 or 16:9) is AFD aware, then the aspect ratio is automatically optimized as it is displayed.

In the PC world, there is a similar implementation that assists in the display of the correct aspect ratio. PC software recorders and players (codecs) have the ability to flag 4:3 and widescreen aspect ratios. Laptop and PC screens display the proper aspect ratio for streaming video due to this ability to flag the aspect ratio. This is not AFD, but a different implementation that is dependent upon the video format and codecs used.

The History of AFD

Flagging and signaling for aspect ratios were first implemented in Europe in conjunction with the rollout of widescreen images for the 625-line-based format. Another format, PAL PLUS, added sidebar information to the 4:3 image to create a widescreen image for widescreen-type displays. PAL PLUS transmits 16:9 as 432 active lines (the standard TV letterbox). PAL PLUS TVs use a "helper" signal (top and bottom) to create 576 lines. These aspect ratio signaling standards are commonly known as widescreen signaling (or WSS) and video index (or VI).

WSS and VI use the same means of inserting flags in the vertical blanking portion of the signal for use in affecting aspect ratio converters and display devices; however, the format of the inserted data is different. For WSS and VI, SD systems are enabled to signal aspect ratio conversion with this standard (not for HD images). Most, if not all, manufacturers of SD aspect ratio converters employ the use of this standard, and it has been employed in Europe for many years.

Why Do We Need AFD?

When a workflow involves the use of SD and HD formats, not only are up-, down- and cross-conversion required, but also aspect ratio conversion. Modern HD systems have upconversion equipment for SD signals. Legacy SD provides a full-screen 4:3 image; however, newer SD cameras have the ability to produce either full-screen 4:3 images or full-screen 16:9 anamorphic images.

The easiest place to add AFD flags is at the point of ingest — either in the up/down/cross converter at the frame sync point or in the server during playout.

Typically, a program signal today will not be identified with an AFD flag. If the programming content always has the same aspect ratio, a default flag for that aspect ratio can be inserted. For instance, during an upconversion from a 4:3 full-screen image to 16:9 pillar box, "1001" identifies a "pillar box" for the HD content. When downconverting, the "1001" flag is used to restore the full-screen 4:3 image. This aspect ratio conversion would be typical of legacy SD programming. See Diagram #1.

A 16:9 anamorphic image, however, will typically expand horizontally to fit the 16:9 aspect ratio. See Diagram #2. This aspect ratio conversion would be typical of more modern SD programming or for SD 270 Mb/s links between facilities carrying downconverted HD signals.

When upconverting these two types of SD aspect ratios for an HD system, the aspect ratio conversion must change. Operator intervention has been necessary because there isn't an automatic method of identifying which aspect ratio conversion is required.

AFD assists with this scenario. If the legacy SD programming has flags identifying it as 4:3 full-screen, and the more modern SD programming has flags identifying it as 16:9 anamorphic, then the upconverter can be told which aspect ratio conversion to apply in order to achieve the desired result.

More likely, the legacy programming will not have any flags (unless it originated in Europe); therefore, a default aspect ratio conversion must be chosen by the user due to the absence of a flag. The key is to add flags as soon as possible so that they can be used in
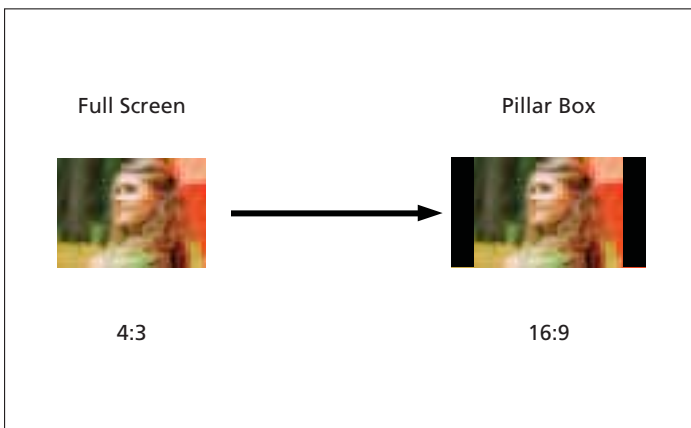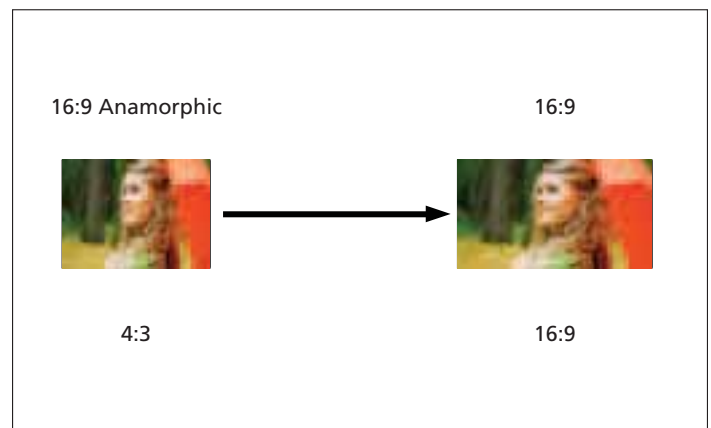

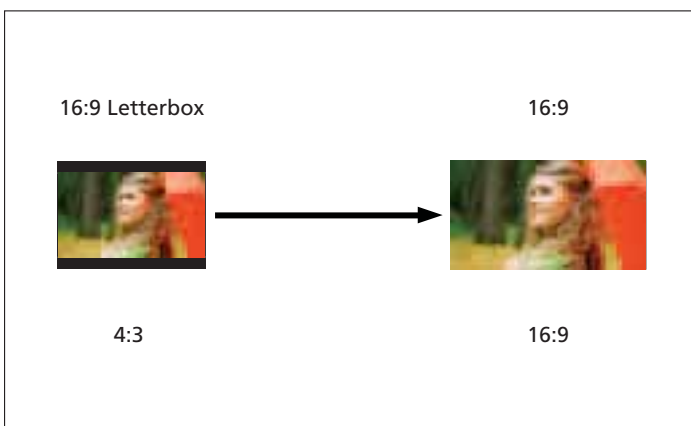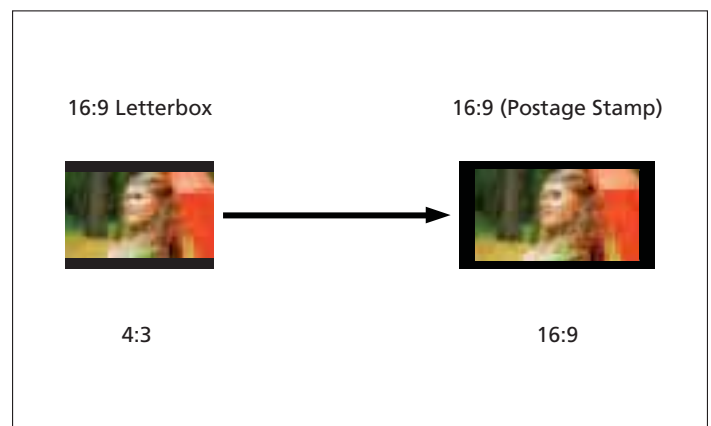Diagram #1

Diagram #2

Diagram #3

Diagram #4

downstream conversion and display devices. Once AFD flags are added, they propagate throughout the system, changing as the aspect ratio changes. AFD can be added in several places — for example, at the time of server ingest or after aspect ratio conversion.

There is no easy way to automatically identify an SD 4:3 full-screen or 16:9 anamorphic image. SD 16:9 letterbox images can be identified by using the black bars; however, this will require extra processing. Anamorphic content cannot be identified relative to full screen.

There is also another aspect ratio in standard definition — letterbox. Typically, motion pictures aired on television are in this aspect ratio. Letterbox can be identified by the black areas in the picture at the top and bottom. In the following letterbox example, a different aspect ratio conversion is required. See Diagram #3.

It is important to note that if the AFD standard is not used in conjunction with the HD picture monitor in the home, the "postage stamp problem" arises. See Diagram #4.

The AFD standard can resolve this issue if it is implemented across the contribution and distribution domains and into the home environment.

Similar scenarios exist for downconversion. HD 16:9 is either cropped, letterboxed or horizontally squeezed. See Diagrams #5, #6 or #7.

If flags are present, the aspect ratio conversion can be affected in the proper manner during downconversion.
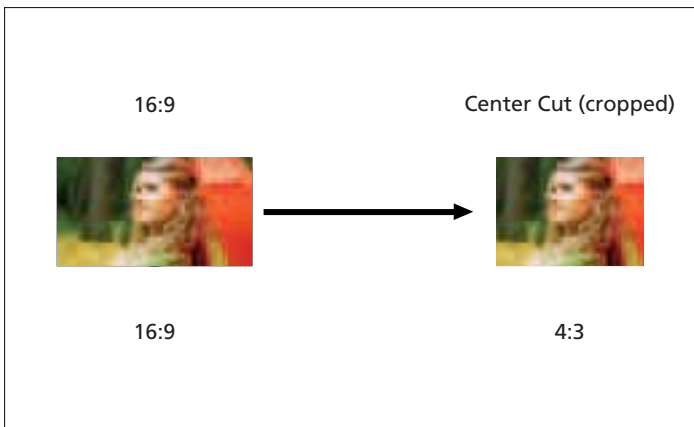

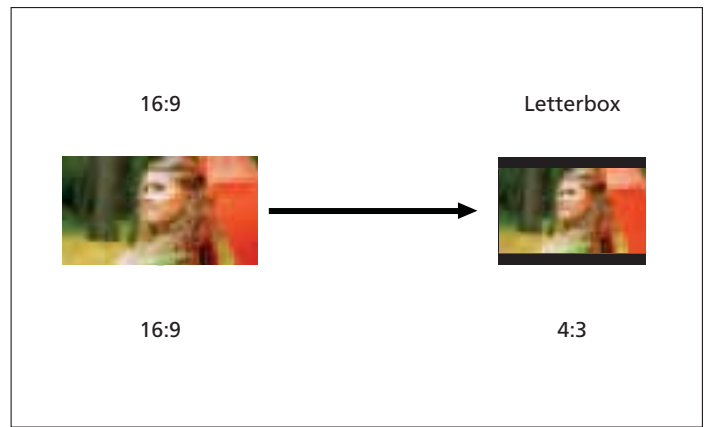16:9   Center Cut (cropped)

16:9   4:3

Diagram #5

16:9   Letterbox

16:9   4:3

Diagram #6

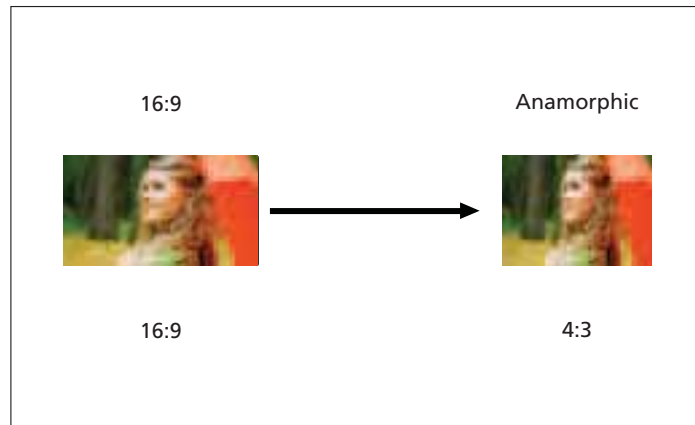16:9   Anamorphic

16:9   4:3

Diagram #7

A System View for AFD

When considering workflow, one should understand the situations in which AFD processing takes place and the situations in which the signal is simply passed through. Routing and distribution equipment simply pass the entire signal through, including the AFD flag.

Processing equipment such as frame syncs, up/down/cross converters, file servers, editors, master control switchers and compression encoders have the means today to process AFD by inserting it, or by using it to adjust the aspect ratio. In the future, consumer STBs and

television sets will have the means to "look at" the AFD and optimize the aspect ratio.

The following diagrams look at a system-wide approach to AFD using "layers." The entire system is represented in Diagram #8.
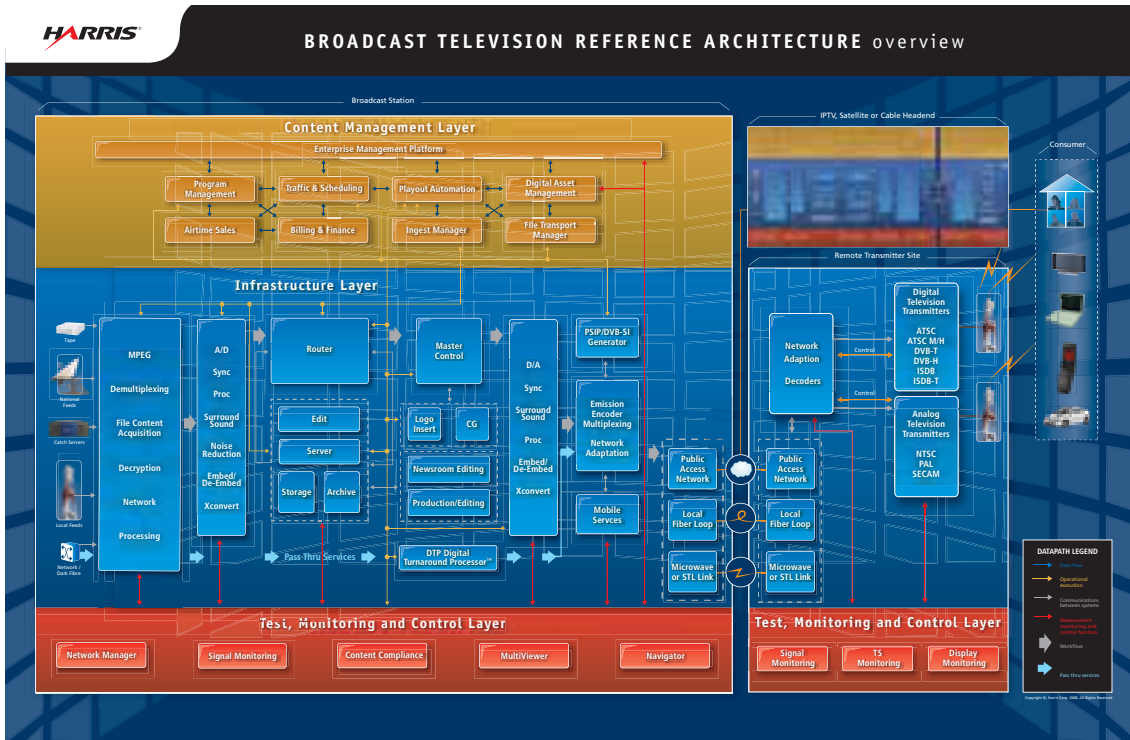
Diagram #8

In the Content Management Layer (Diagram #9), AFD metadata is stored against content which is itself related to physical tapes and files. Scheduling of content gives all metadata related to the content a date-time stamp. Metadata (inclusive of AFD) moves among systems (for example, traffic to playlist to automation). This allows automation to use the AFD data to trigger the required device, based upon receipt of the traffic schedule.

In addition, AFD can be helpful as a metadata element within content databases. In a similar fashion as outlined above with schedules, industry-standard protocols, such as BXF, can be used to achieve smooth and automated flow of AFD information among broadcast systems.
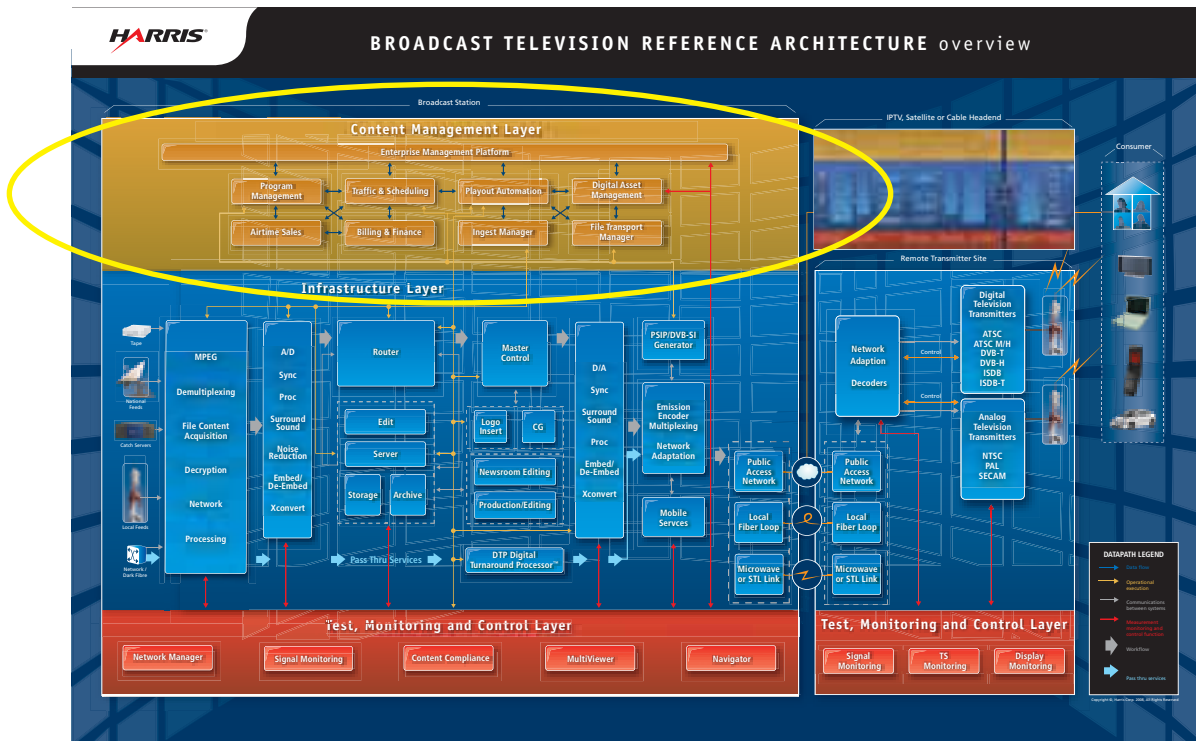

Diagram #9

In the Infrastructure Layer (Diagram #10), HD encoders take in AFD from VANC on inputs for compressed video user data in ATSC and DVB (and ISDB-Tb) modes. In decoders, regenerating AFD in VANC is done based on the combination of WSS, VI, AFD and local user settings. (SD encoders implement WSS and VI).
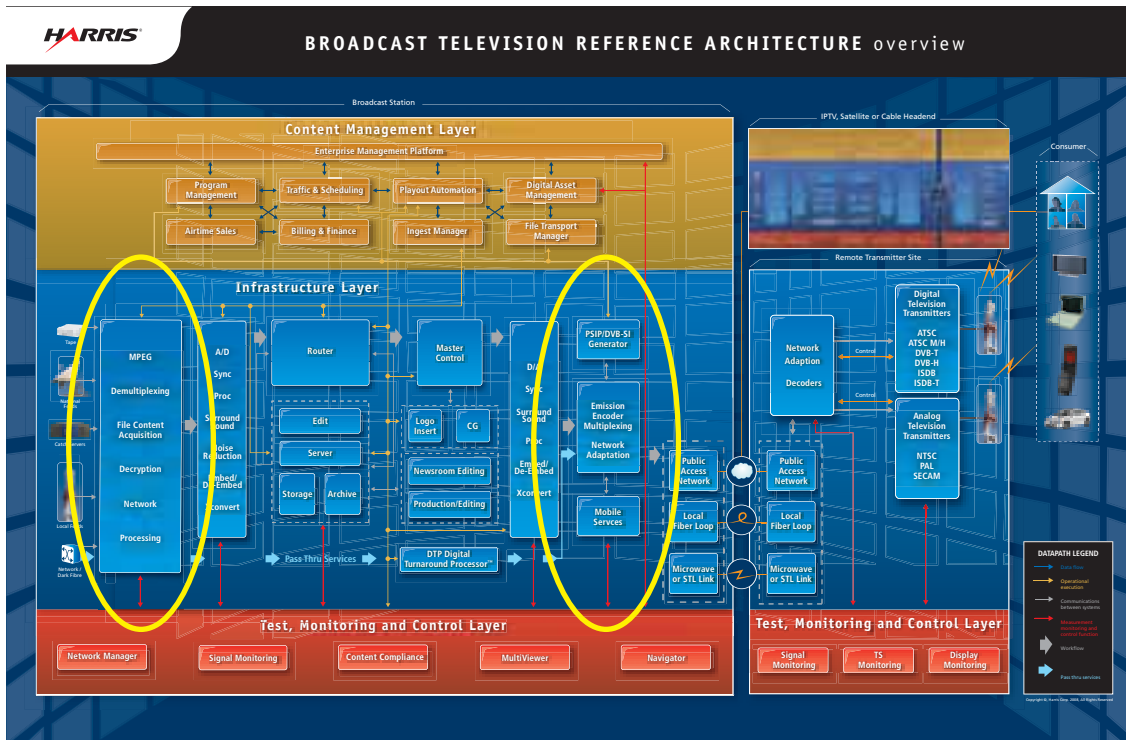

Diagram #10

In Diagram#11, if AFD is not present at ingest, the AFD flag may be a default or chosen by an operator. After insertion, the AFD flag may be used downstream to signal aspect ratio converters. The AFD flag is automatically updated when this happens for further processing downstream.
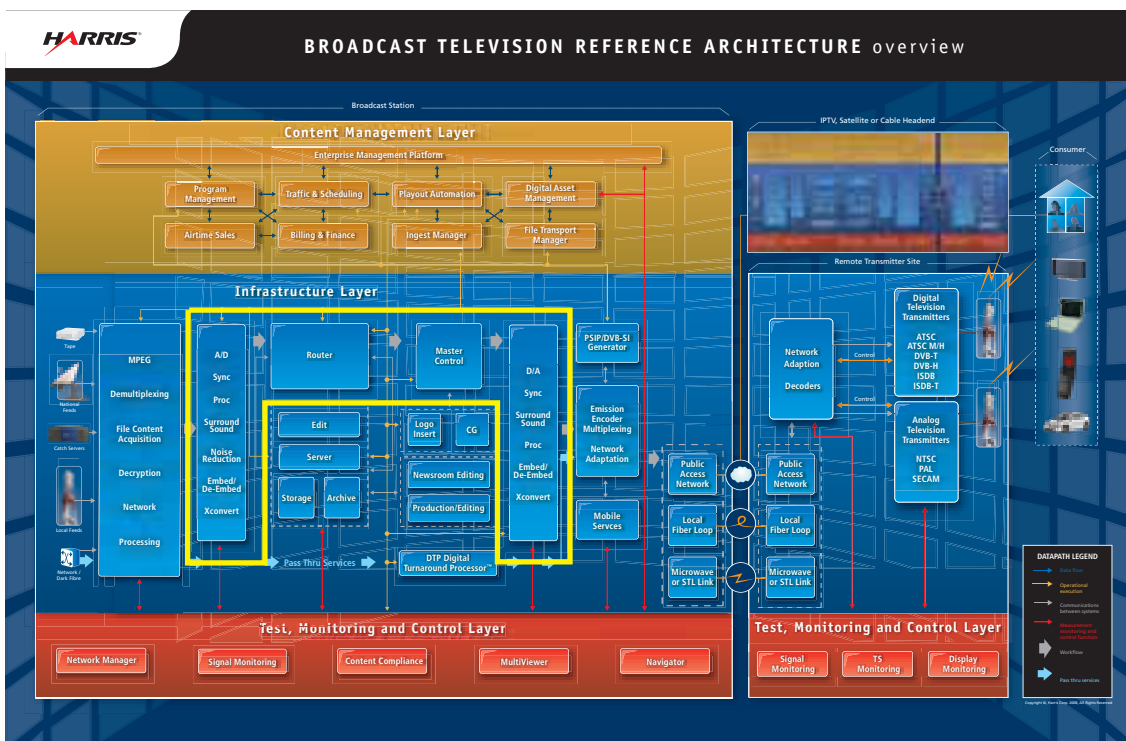

Diagram #11

In the Test, Monitoring and Control Layer (Diagram#12), measurement/monitoring devices, such as multi-image processing devices (multiviewers) and video monitors, show the presence of metadata such as AFD and bar data.
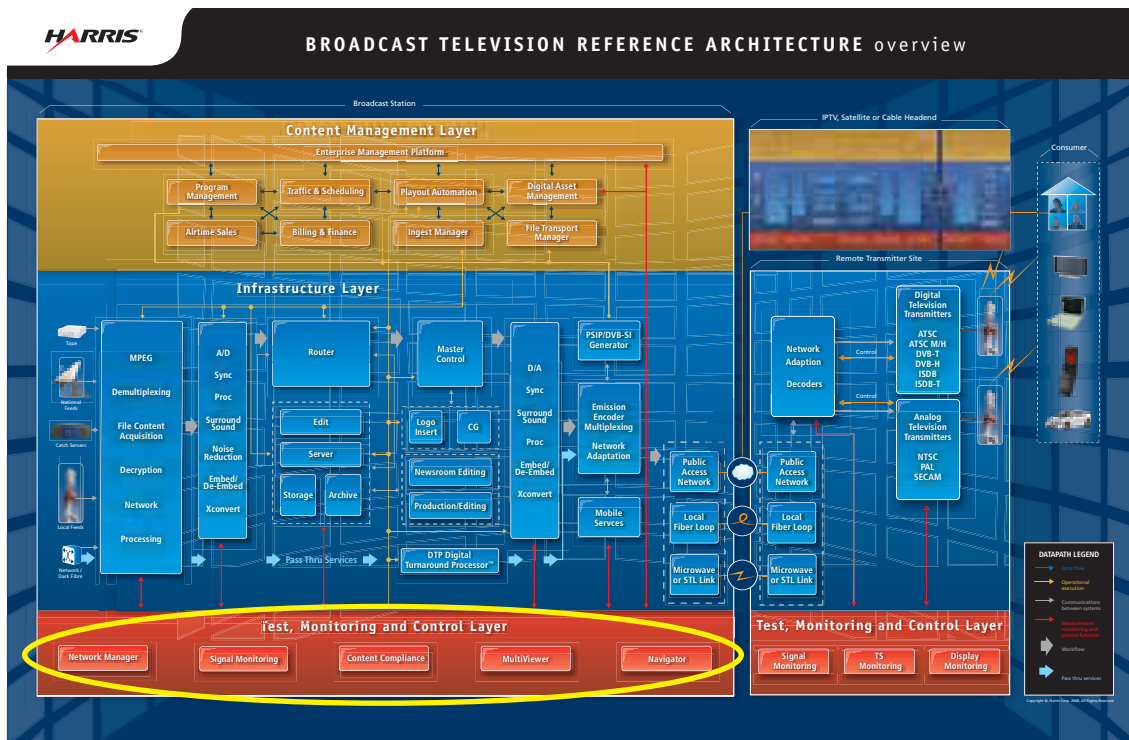

Diagram #12

In Diagram #13, servers and editors have the ability to read, write, modify and react to AFD codes. During playback, servers will perform up- and down-conversion based on predefined rules from the AFD of the content being played out. As conversion is performed, the new AFD codes are written into the VANC.
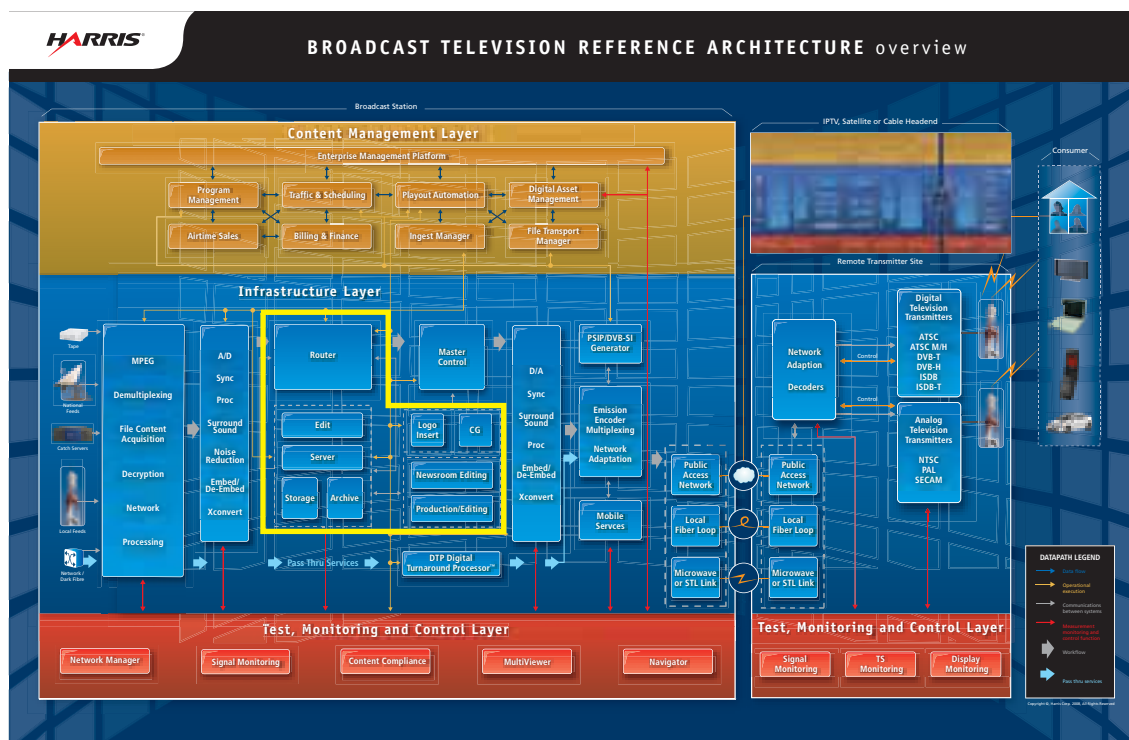

Diagram #13

Considerations for Use Today

Once a signal has been identified by an AFD flag, it is very important that this information be propagated through the entire system. Once AFD is lost, the entire idea behind AFD falls apart.

Therefore, if there are no AFD flags in place, they must be added automatically or manually by an operator. The operator must look at the image on a picture monitor and set up the aspect ratio converter properly. Today's control environments allow for a remote panel at the operator's location with easy-to-find status for flag presence and pushbuttons for each type of aspect ratio encountered.

Monitoring the signal for the presence of the AFD flag will assist the operator. When an alarm occurs in the typical waveform/vector/data/metadata monitoring equipment display used today, the operator then chooses the appropriate action.

If the AFD flags disappear, the equipment processing the AFD flags should have a setting for either remaining at the last-known AFD flags setting or defaulting to a user-selected AFD flag.

As many cable and DBS operators will simply "center cut" HD for SD distribution, graphics branding will likely continue to be located inside the 4:3 window of a 16:9 image (station logo will be in the middle of the screen). However, if the graphics designer created both a 4:3 and 6:9 graphic, and the saved files were called out using AFD, this may be possible by using AFD flags.

Broadcasters and content producers will likely still not assume letterbox HD broadcasts inside an SD transmission and will continue to shoot and produce in the cropped center. It seems that a letterbox image in a legacy television set is not acceptable to the viewing public.

As AFD rolls out, there will be some issues that arise. As AFD propagates through some older STBs, it will interfere with the closed captioning information. Some TV sets with AFD do not operate as advertised. Some TV sets identify black bars and make decisions on the aspect ratio to be displayed, and this may or may nor be the default setting.

The ATSC and CEA are standardizing AFD; however, in other parts of the world (where DVB dominates), is the same standardization taking place? One other consideration is who will insert flags for commercials — the producer of the commercial or the broadcaster?

Conclusion

Active Format Description can significantly improve the workflow in a hybrid SD/HD system. AFD ensures that the correct aspect ratio is used when converting between differing video formats. A flag inserted into the VANC describes the aspect ratio so that downstream devices can provide the correct aspect ratio. If the program signal continues, the flag is updated with the new aspect ratio for further processing downstream. In essence, AFD simplifies the use of aspect ratio conversion in today's complex television environments.

For more information please visit www.broadcast.harris.com.